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NATIONAL DAM SAFETY PROGRAM. SIEGMUND LAKE DAM (MO-30520), MISS--ETC(U)
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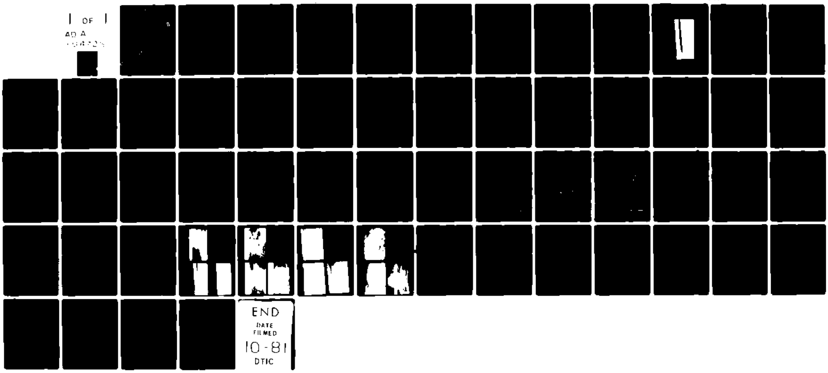

LEVEL II

MISSOURI - KANSAS CITY BASIN

AD A104725

SIEGMUND LAKE DAM

WARREN COUNTY, MISSOURI

MO 30520

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PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Siegmund Lake Dam (MO-30520),
Missouri - Kansas City Basin.
Warren County, Missouri.
Phase I Inspection Report.

DISTRIBUTION STATEMENT A
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(9) Final rept.,

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Albert B. /Becker, Jr

United States Army
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St. Louis District

(15) DACW43-81-C-0002

(11) Jun 81 (12)

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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MISSOURI - KANSAS CITY BASIN

SIEGMUND LAKE DAM

WARREN COUNTY, MISSOURI

MO 30520

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JUNE 1981

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Siegmund Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Siegmund Lake Dam (MO 30520):

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

2) Overtopping of the dam could result in failure of the dam.

3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 16 JUN 1981 (Date)

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 18 JUN 1981 (Date)

SIEGMUND LAKE DAM

MISSOURI INVENTORY NO. 30520

WARREN COUNTY, MISSOURI

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

JUNE 1981

HS-8088

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Siegmund Lake Dam
State Located:	Missouri
County Located:	Warren
Stream:	Sub-tributary of Charrette Creek
Date of Inspection:	4 December 1980

The Siegmund Lake Dam, which according to the St. Louis District, Corps of Engineers, is of high hazard potential, was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses an inordinate danger to human life or property. Evaluation of this dam was performed in accordance with the "Phase I" investigation procedures prescribed in "Recommended Guidelines for Safety Inspection of Dams", dated May 1975.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of the hydrologic/hydraulic investigations, the present general condition of the dam is considered to be less than satisfactory. Several items were noticed during the inspection which are considered to have an adverse effect on the overall safety and future operation of the dam. These items, which are considered to be deficiencies, include deterioration of the upstream face of the embankment, the lack of adequate turf cover on the crest and certain areas of the upstream and downstream faces of the dam as well as the lack of a suitable form of protection, such as riprap, to prevent erosion of the upstream face by wave action or by fluctuations of the lake level, subsidence of the dam at what appeared to be a collapsed animal burrow,

seepage near the toe of the embankment in the original valley fill, erosion of areas adjacent to the downstream toe of the dam, and the presence of trees on the downstream face of the dam.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Siegmund Lake Dam, which, according to Table 1 of the guidelines, is classified as small in size, is specified, according to Table 3 of the guidelines for a dam of high hazard potential and small size, to be a minimum of one-half the Probable Maximum Flood (PMF). The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Considering the fact that portions of the Innsbrook Subdivision development including a number of dwellings and Dam No. 11243, the Lake Innsbrook Dam, which is also classified by the Corps of Engineers as being of high hazard potential, all lie within the potential flood damage zone for this dam, and since failure of the Siegmund Lake Dam by overtopping could result in failure of the downstream dam which, in addition, would endanger the lives of a number of people living within the downstream flood damage zone for the Lake Innsbrook Dam, it is recommended that the spillway for the Siegmund Lake Dam be designed for the full PMF.

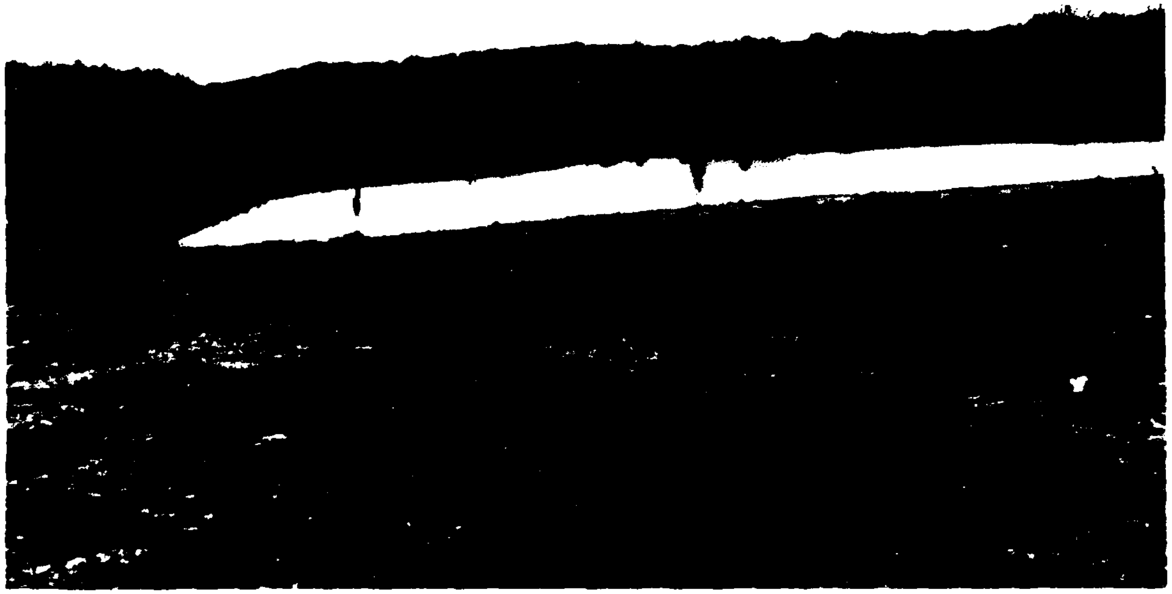
Results of a hydrologic/hydraulic analysis indicated that the spillway is inadequate to pass lake outflow resulting from a storm of PMF magnitude without overtopping the dam. The spillway is capable of passing lake outflow corresponding to about 24 percent of the PMF lake inflow and the lake outflow resulting from the 1 percent chance (100-year frequency) flood. According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be two miles. Within the potential damage zone are portions of the Innsbrook Subdivision development including a number of dwellings and the Lake Innsbrook Dam. No determination was made whether or not failure of the Lake Innsbrook Dam would occur so far as any of the flood events or conditions of overtopping investigated herein are concerned.

A review of available data did not disclose that seepage or stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action within the near future to correct or control the deficiencies and safety defects reported herein. The item concerning the provision of additional spillway capacity should be pursued on a high priority basis.

Ralph E. Sauthoff
P. E. Missouri E-19090

Albert B. Becker, Jr.
P. E. Missouri E-9168



OVERVIEW SIEGMUND LAKE DAM

PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

SIEGMUND LAKE DAM - MO 30520

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

SIEGMUND LAKE DAM - MO 30520

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, directed that a safety inspection of the Siegmund Lake Dam be made.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the dam with respect to safety and, based upon available data and this inspection, determine if the dam poses an inordinate danger to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in the "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams", dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Decription of Dam and Appurtenances. The Siegmund Lake Dam is an earthfill type embankment rising approximately 30 feet above the natural streambed at the downstream toe of the barrier. Across the entire lake side of the dam and particularly near the ends of the dam, the slope of the upstream face is quite irregular. This irregularity is apparently due to the fact that cattle watering in the lake and grazing on the slope have damaged the embankment. Near the crest, the upstream slope is approximately 1v on 3.6h, but closer to the waterline, the slope steepens to about 1v on 1.3h, and

erosion of the embankment has resulted in deposition, or washing, of the embankment material into the lake. At the surveyed cross-section, which is considered to be fairly representative of the entire dam, the embankment has a crest width of approximately 12 feet and a downstream slope that varies from about 1v on 3.0h near the crest of the dam to approximately 1v on 2.5h at the toe of the dam. The length of the dam is approximately 710 feet and the dam is curved somewhat away from the lake between abutments. A plan and profile of the dam are shown on Plate 3 and a cross-section of the dam, at about the location of the original stream on which the dam was constructed, is shown on Plate 4. At normal pool elevation, the reservoir impounded by the dam occupies approximately 6.3 acres. According to the Owner, there is no lake drawdown facility to dewater the lake. An overview photo of the Siegmund Lake Dam is shown following the preface at the beginning of the report.

The spillway for the dam, a rather shallow excavated earth trapezoidal section, is located at the right, or west, abutment adjacent to the dam. The spillway outlet channel, an irregular earth section, cuts through the drainage divide of the right abutment and joins the natural watercourse of the adjacent watershed at a point approximately 400 feet due west of the dam. A profile of the spillway channel along with several cross-sections of the channel at selected locations, are shown on Plate 5.

b. Location. The dam is located on an unnamed sub-tributary of Charrette Creek about 1.0 mile southwest of the intersection of State Highways M and F; about 3.5 miles south of the community of Wright City, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located within the northeast one-quarter of Section 5 of Township 46 North, Range 1 West, in Warren County.

c. Size Classification. The size classification based on the height of the dam and storage capacity, is categorized as small (per Table 1, Recommended Guidelines for Safety Inspection of Dams). A small size dam is classified, according to the guidelines, as having a height less than 40 feet but greater than or equal to 25 feet and/or a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The Siegmund Lake Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning that if the dam should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends two miles downstream of the dam. Within the potential damage zone are portions of the Innsbrook Subdivision development including a number of dwellings and Dam No. 11243, which according to the Corps of Engineers, also has a high hazard classification. Those features lying within the downstream damage zone as reported by the St. Louis District, Corps of Engineers, were verified by the inspection team.

e. Ownership. The lake and dam are owned by Delores Siegmund. Mrs. Siegmund's address is: Box 128, Route 1, Wright City, Missouri 63390.

f. Purpose of Dam. The dam impounds water for recreational use and for the watering of farm animals.

g. Design and Construction History. According to the Owner, Mrs. Delores Siegmund (Mr. Siegmund is deceased), the dam was constructed about 1965 by Ward Lefferdink, an excavating contractor of Warrenton, Missouri. When contacted, Mr. Lefferdink stated that he had no knowledge of the Siegmund Dam and indicated that the dam was probably constructed by his father, Frank Lefferdink (deceased) who was in the excavating business during the time the dam was built under the name of the Acme Construction Company. In any event, no records or data pertaining to the design or construction of the dam were available.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacity of an excavated earth type spillway.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake is about one-third meadowland and two-thirds woodland. The watershed above the dam amounts to approximately 34 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

1. Estimated known maximum flood at damsite ... 25 cfs* (W.S. Elev. 752.0)
2. Spillway capacity ... 57 cfs (W.S. Elev. 752.4)

c. Elevation (Ft. above MSL). Except where noted, the following elevations were determined by survey and are based on the elevation of the lake, assumed to be the normal pool level, as shown on the 1972 USGS Wright City, Missouri, Quadrangle Map, 7.5 Minute Series.

1. Observed pool ... 749.3
2. Normal pool ... 751.0
3. Spillway crest ... 751.0
4. Maximum exprienced pool ... 752.0*
5. Top of dam ... 752.4 (Min.)
6. Streambed at centerline of dam ... 727± (Est.)
7. Maximum tailwater ... Unknown
8. Observed tailwater ... None

d. Reservoir.

1. Length at normal pool (Elev. 751.0) ... 875 ft.
2. Length of pool at top of dam (Elev. 752.4) ... 900 ft.

e. Storage.

1. Normal pool ... 44 ac.ft.
2. Top of dam ... 53 ac.ft.

f. Reservoir Surface Area.

1. Normal pool ... 6.3 acres
2. Top of dam ... 7.0 acres

*Based on estimate of lake level per Owner.

g. Dam. The structural height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier, to the top of dam.

1. Type ... Earthfill
2. Length ... 710 ft.
3. Height ... 30 ft.
4. Top width ... 12 ft.
5. Side slopes
   a. Upstream ... 1v on 3.6h to 1v on 1.3h (above waterline)
   b. Downstream ... 1v on 3.0h to 1v on 2.5h
6. Cutoff ... Unknown
7. Slope protection
   a. Upstream ... Grass (very sparse)
   b. Downstream ... Grass

h. Principal Spillway.

1. Type ... Uncontrolled, excavated earth, trapezoidal section
2. Location ... Right abutment
3. Crest ... Elevation 751.0
4. Bottom width ... 3 ft.
5. Side slopes ... Varies
6. Approach channel ... Lake
7. Outlet channel ... Irregular, excavated earth section

i. Emergency Spillway ... None

j. Lake Drawdown Facility ... None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Date relating to the design of the dam were unavailable.

2.2 CONSTRUCTION

As previously indicated, the dam was constructed about 1965 by, in all probability, Frank Lefferdink, a general contractor who operated the Acme Construction Company. Mr. Lefferdink is deceased and no information or data pertaining to the construction of the dam were available.

2.3 OPERATION

The lake level is uncontrolled and governed by the elevation of the crest of the excavated earth spillway. There is no lake drawdown facility. No indication was found that the dam has been overtopped. According to the Owner, Mrs. Delores Siegmund, the dam has never been overtopped. Mrs. Siegmund reported that, in her estimation, the highest lake level observed was about 12 inches above the crest of the spillway. Although not actually observed, Mrs. Siegmund stated that in 1974, following a large storm, lake outflow resulted in considerable erosion of the spillway outlet channel; however, no estimate of lake level or depth of flow within the spillway for this storm event could be made.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillway were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Siegmund Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, H. B. Lockett, Hydrologist, and A. B. Becker, Jr., Civil and Soils Engineers, on 4 December 1980. The Owner was on site, but did not accompany the inspection team during the inspection. An examination of the dam site was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the area geology. Also examined at the time of the inspection were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on pages A-1 through A-4 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. Siegmund Lake is located on the uplands, near the headwaters of an unnamed tributary of Charrette Creek. The topography is gently rolling, and there is only 50-75 feet of relief between the reservoir and the surrounding drainage divides.

The site is located in the southern portion of the Dissected Till Plains Section of the Central Lowlands Physiographic Province, near its border with the Ozark Plateaus Physiographic Province. No bedrock outcrops were observed at the site; however, subsurface borings from adjacent projects indicate over 100 feet of glacial till and loessal deposits overlay limestone of the Ordovician-age Kimmswick formation. There is little bedrock structure. The sedimentary strata dip gently toward the north, and no faults are reported in the vicinity.

The Kimmswick formation is a light gray, coarsely crystalline, medium-bedded to massive limestone. Weathered exposures characteristically appear pitted. The limestones are susceptible to solution weathering and may have solution-enlarged joints and bedding planes, sinkholes, etc. Often the karst features are filled with Pennsylvanian-age rubble.

The unconsolidated surficial materials consist of thick deposits of loess and glacial drift. The dam and reservoir are located on soils of the Keswick series. These soils are deep, moderately well-drained materials formed from glacial till with loess mixed in the upper layers. They are dark grayish-brown silts near the surface and become more clayey with depth. The soils are classified as CL or CL-ML materials (Unified Soil Classification System), are low in permeability, and are susceptible to erosion. The silty soils of the Hatton series cap the ridges above the reservoir. These soils were formed from loess deposits and exhibit engineering properties similar to the Keswick soils. Glacial till overlaid with loess was noted in the stream channel immediately downstream from the dam. The till consisted primarily of blocky clay with chert gravel and large glacial erratics.

With the exception of the susceptibility to erosion of the surficial soils, there appear to be no significant geotechnical problems at the Siegmund Dam site. No other adverse geologic conditions were observed that would affect the performance of the dam or reservoir.

c. Dam. The visible portions of the upstream and downstream faces of the dam, as well as the dam crest (see Photos 1, 2 and 3) were examined and, except as noted herein, found to be in sound condition. In the vicinity of the abutments, the upstream face of the dam was badly eroded, apparently by cattle traffic, with deterioration of the slope extending from the crest of the dam to below the observed waterline. Across the remainder of the dam, minor erosion that appeared to be due to wave action or fluctuations of the lake level had created a near vertical bank approximately 6 inches high at the normal waterline. Also, near the ends of the dam, material eroded from the face of the dam had formed a berm at about the waterline that projected into the lake. In the areas of the upstream face disturbed by cattle, no turf cover existed; across the crest of the dam, the turf cover was very sparse and many cow paths were observed. Several cow paths without turf cover were also noticed across the downstream face of the dam as well as several cedar trees (see Photo 12) up to 5 inches in diameter. The remnants of what appeared to be an animal burrow, as evidenced by subsidence of the embankment at the burrow (see Photo 11), were noticed in the upstream face of the dam at about station 5+75. No trees were observed on the crest or upstream face of the dam.

No sliding of the slopes, cracking of the surface of the dam, or undue settlement of the crest were observed, although the top of the dam was found to be somewhat irregular in elevation along the longitudinal centerline of the structure and it is possible that some minor settlement of the structure has occurred. It is also possible that cattle trafficking the top have eroded the crest of the dam in certain locations more so than in others. Examination of a soil sample obtained from the downstream face of the embankment near the center of the dam indicated the surficial material to be a yellow-brown, silty lean clay (CL) of low-to-medium plasticity.

A wet area (see Photo 7) with soft ground and pockets of standing water, approximately 80 feet wide and 135 long, that appeared to be due to seepage was found in the original valley fill just downstream of the dam opposite station 7+65. A similar area but somewhat more marshy (see Photo 8), was observed near the toe of the dam opposite station 5+55. Flow from either of these areas could not be detected, and therefore, the amount of seepage could not be estimated.

A gully, approximately 2.5 feet deep and 12 feet wide at the lower end, was noticed near the downstream toe of the dam (see Photo 9) opposite station 6+35. This gully was probably a result of erosion by spillway flows prior to the relocation of the spillway outlet channel to its present location. The Owner indicated that some erosion was noticeable along the course of the old spillway channel. Another gully, about 1.5 feet deep and 6 feet wide at the lower end, was noticed near the toe of the dam (see Photo 10) opposite station 9+05. Two more gullies, about 1.3 feet deep and up to 2 feet in width, were observed at the junction of the left abutment and the upstream side of the dam. The gullies opposite station 9+05 and at the left abutment appeared to be a result of erosion by overland drainage.

The excavated earth spillway (see Photo 4) was inspected and found to be in less than satisfactory condition. At the lake, the spillway had no form of protection to prevent erosion by lake outflow and the earth embankment was badly degraded, apparently as a result of cattle trafficking the area in order to access the lake. The spillway outlet channel (see Photo 5) was also unprotected, although tree branches and other forms of debris had been placed within the channel (see Photo 6) at numerous locations in an attempt to

prevent erosion; however, some minor erosion of the channel invert and banks was evident through both the protected and unprotected reaches of the channel. Although the tree branches, etc., had been placed in the channel to prevent erosion of the section, it was also apparent that they could also obstruct flow in the channel and reduce its capacity. Downstream of the crest section, the channel was not very discernible, but appeared to follow a course down the hillside and into the woods where it joined the natural stream channel of the adjacent watershed at a point about 400 feet west of the dam.

d. Appurtenant Structures. No appurtenant structures were observed at this dam site.

e. Downstream Channel. The channel joins Lake Innsbrook at a point approximately 0.6 of a mile downstream of the dam. The Lake Innsbrook Dam is located about 1.1 miles downstream of the Siegmund Lake Dam. Except at roadway crossings and at Lake Innsbrook, the channel downstream of the dam is unimproved. The channel section is irregular and for the most part, lined with trees.

f. Reservoir. The area east of the lake and an area approximately 400 feet long at the dam end of the lake are meadowland and apparently are used for pasture. Elsewhere the area adjacent to the reservoir is woodland and in a natural state. Along the shoreline extending from the dam upstream for about 400 feet, moderate erosion of the banks on the east and west sides of the lake was noticeable. The amount of sediment within the lake attributable to this erosion as well as the erosion that has occurred across the upstream face of the dam could not be determined; however, relative to the total storage volume of the lake, the quantity is believed to be hydrologically insignificant. At the time of the inspection, the lake water was clear and the level was about 1.7 feet below the spillway crest.

3.2 EVALUATION

The deficiencies observed during this inspection and noted herein are not considered of significant importance to warrant immediate remedial action. Recommendations regarding correcting or controlling the deficiencies indicated herein are included in Section 7, paragraph 7.2b.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The lake surface level is governed by precipitation runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

According to the Owner, Mrs. Delores Siegmund, with the exception of the placing of tree branches within the spillway outlet channel in order to prevent erosion, virtually no routine maintenance of the dam has been performed. Mrs. Siegmund reported that she intends to arrange for trapping of muskrats noticed about the dam sometime this winter.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet facilities requiring operation exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection did not reveal the existence of a dam failure warning system.

4.5 EVALUATION

The practice of allowing cattle to traffic across or to graze on the dam and to water in the lake at the dam is considered harmful to the embankment and should be discontinued. Deterioration of the upstream face of the dam as well as the lack of turf cover on the upstream face, crest and downstream face of the dam are believed to be due primarily to the presence of these animals. It is further recommended that trees on the dam be removed and that some form of erosion protection other than grass be provided across the upstream face of the dam. It is also recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and

construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available.

b. Experience Data. The drainage area and lake surface area were determined from the 1972 USGS Wright City, Missouri, Quadrangle Map. The proportions and dimensions of the spillway and dam were developed from surveys made during the inspection. Records of rainfall, streamflow, or flood data for the watershed were not available.

Due to the fact that the watershed for this reservoir is small and since there is no history of excessive reservoir leakage that would adversely affect the normal operational level of the lake, the lake level was assumed to be at normal pool (spillway crest) as a result of antecedent storms prior to occurrence of the probable maximum flood and the probabilistic storm.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends two miles downstream of the dam. Dam No. 11243 lies about 1.1 miles downstream of the Siegmund Lake Dam.

c. Visual Observations.

(1) The spillway, an excavated earth trapezoidal section, is located at the right, or west, abutment.

(2) The spillway outlet channel cuts through the drainage divide of the right abutment and joins the natural watercourse of the adjacent watershed at a point approximately 400 feet due west of the dam.

(3) Due to the fact that the spillway outlet directs flow away from the dam, lake outflow within the capacity of the spillway outlet should not endanger the dam.

(4) There is no lake drawdown facility.

(5) A small island on the order of 0.2 of an acre lies within the reservoir near the upstream end of the lake. The island was considered to be hydrologically insignificant so far as the investigations contained herein are concerned.

d. Overtopping Potential. The spillway is inadequate to pass the probable maximum flood, or 1/2 the probable maximum flood, without overtopping the dam. The spillway is adequate, however, to pass the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of the dam overtopping analyses are as follows:

(Note: The data appearing in the following table were extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth (Ft.) of Flow over Dam (Elev. 752.4)	Duration of Overtopping of Dam (Hours)
0.50	188	753.2	0.8	2.8
1.00	645	753.8	1.4	6.3
1% Chance Flood	40	752.2	0.0	0.0

Elevation 752.4 was considered to be the lowest point in the dam crest. The flow safely passing the spillway just prior to dam overtopping was determined to be approximately 57 cfs, which is the routed outflow corresponding to about 24 percent of the probable maximum flood inflow. This flow is greater than the outflow from the 1 percent chance (100-year frequency) flood. During peak flow of the probable maximum flood, the greatest depth of the flow over the dam is projected to be 1.4 feet and overtopping will extend across approximately 260 feet of the dam crest at the right abutment and about 150 feet of the crest near the left abutment.

e. <u>Evaluation</u>. Experience with embankments constructed of similar material (a silty lean clay of low-to-medium plasticity) to that used to construct this dam has shown evidence that under certain conditions, such as high velocity flow, the material can be very erodible. Such a condition exists during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition where the depth of flow over the dam crest, a maximum of 1.4 feet, and the duration of flow over the dam, 6.3 hours, are substantial, damage by erosion to the crest and downstream face of the dam is expected. The extent of these damages is not predictable within the scope of this investigation; however, there is a possibility that they could result in failure by erosion of the dam. A similar, but not as severe, condition also exists during occurrence of the one-half PMF events.

f. <u>References</u>. Procedures and data for determining the probable maximum flood, the 100-year flood, and the discharge rating curve for flow passing the spillway and dam crest are presented on pages B-1 and B-2 of Appendix B. Listings of the HEC-1 (Dam Safety Version) input data for both the probable maximum flood, and the probabilistic flood, are shown on pages B-3 through B-5. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-6 through B-9; tabulation of lake surface area, elevation and storage volume is shown on page B-10; tabulations titled "Summary of Dam Safety Analysis" for the PMF and the 1 percent chance (100-year frequency) flood are also shown on page B-10 of Appendix B.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which adversely affect the structural stability of the dam are discussed in Section 3, paragraph 3.1c.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to the Owner, Mrs. Delores Siegmund, no records of lake level, spillway discharge, dam settlement, or lake seepage have been kept.

d. Post Construction Changes. The only post construction change reported by the Owner that may affect the structural stability of the dam concerns relocation of the spillway outlet channel. Mrs. Siegmund reported that originally, the spillway outlet channel followed a course that directed it down the hillside of the right abutment adjacent to the toe of the dam until it reached the original stream channel on which the dam was built at a point just downstream of the dam. In 1979, reportedly after having experienced considerable erosion of the channel near the toe of the dam, the spillway channel was relocated to its present location. According to Mrs. Siegmund, the task of relocating the channel was done by friends. Mrs. Siegmund indicated that no other changes have been made or have occurred which would affect the structural stability of the dam. A possible exception would be the damage to the upstream face of the dam caused by cattle trafficking the crest and watering in the lake.

e. Seismic Stability. The dam is located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillway is capable of passing lake outflow of about 57 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff of probable maximum flood magnitude, the lake outflow would be about 645 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 40 cfs. Since the existing spillway is inadequate to pass lake outflow resulting from a storm of PMF magnitude (the recommended spillway design flood for this dam) without overtopping the dam, the possibility exists that overtopping could result in failure by erosion of the dam. A description of the features within the potential flood damage zone should failure of the dam occur is presented in Section 1, paragraph 1.2d.

Seepage and stability analyses of the dam were not available for review, and therefore, no judgement could be made with respect to the structural stability of the dam.

Several items were noticed during the inspection that could adversely affect the safety of the dam. These items include deterioration of the upstream face of the embankment, the lack of adequate turf cover on the crest and certain areas of the upstream and downstream faces of the dam as well as the lack of a suitable form of protection, such as riprap, to prevent erosion of the upstream face by wave action or by fluctuations of the lake level, subsidence of the dam at what appeared to be a collapsed animal burrow, seepage near the toe of the embankment in the original valley fill, erosion of areas adjacent to the downstream toe of the dam, and the presence of trees on the downstream face of the dam.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacities of the spillways were based on a hydrologic/

hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The remedial measures recommended in paragraph 7.2 for the items concerning the safetv of the dam noted in paragraph 7.1a should be accomplished within the near future. The item concerning the provision of additional spillway capacity should be pursued on a high priority basis.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended.

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased in order to pass lake outflow resulting from a storm of probable maximum flood magnitude, the recommended spillway design flood for this dam. In either case, the spillway including the spillway outlet channel should be protected to prevent erosion.

(2) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams.

b. <u>Operations and Maintenance (O & M) Procedures</u>. The following O & M Procedures are recommended:

(1) Discontinue the practice of allowing cattle to graze on or traffic across the dam, or to water in the lake at the dam. Cattle, or any other kind of stock, can be damaging to the dam since their presence destroys the protective turf cover which promotes deterioration and/or erosion of the embankment, either of which can impair the structural stability of the dam.

(2) Restore the eroded areas of the dam including the subsided area at the apparent animal burrow and the eroded areas adjacent to the downstream toe of the dam, and provide some form of turf cover (except where otherwise indicated) in order to prevent erosion of the embankment by overland drainage. Loss of embankment material and foundation material adjacent to the dam due to erosion can impair the structural stability of the dam.

(3) Provide some form of protection, such as riprap, for the upstream face of the dam at and above the normal waterline in order to prevent erosion by wave action or by fluctuations of the lake level. A grass covered slope is not considered adequate protection to prevent erosion by wave action or by fluctuations of the lake level. As indicated above, loss of embankment material due to erosion can impair the structural stability of the dam.

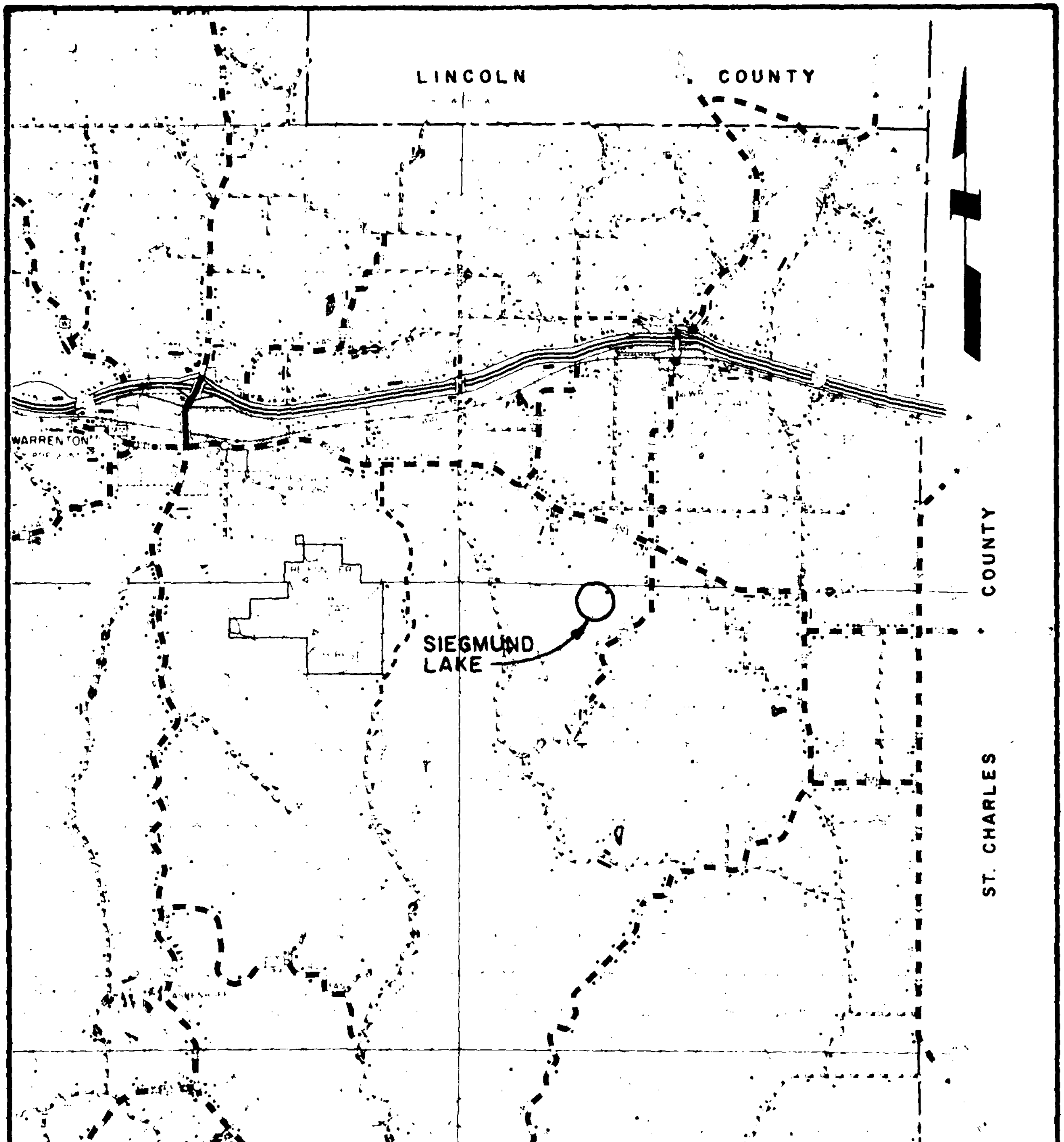
(4) Provide some means of controlling seepage believed to be responsible for the wet and marshy areas just downstream of the toe of the dam. Uncontrolled seepage can lead to a piping condition (progressive internal erosion) that can result in failure of the dam. Drainage of the areas affected by seepage should be one of the ojectives of the seepage control measures since saturation of the soil weakens the foundation which can impair the structural stability of the dam.

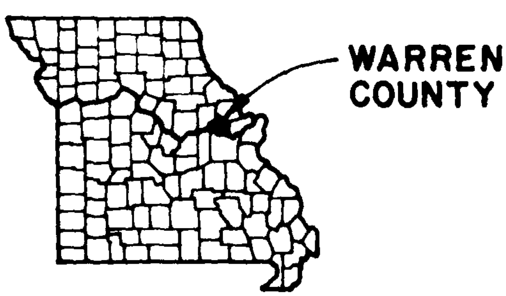
(5) Remove the trees from the dam proper. The removal of trees should be performed under the guidance or supervision of an engineer experienced in the design and construction of earth dams, since indiscriminate removal of trees could jeopardize the safety of the dam. Where trees are removed, the turf cover should be restored if destroyed or missing. Maintain

the turf cover at a height that will not hinder inspection of the embankment or provide cover for burrowing animals. Holes from tree roots and animal burrows can provide passageways for lake seepage that could also result in a piping condition which, as previously stated, can lead to failure of the dam.

(6) Provide maintenance of all areas of the dam and spillway on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(7) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended for future reference, that records be kept of all inspections made and remedial measures taken.

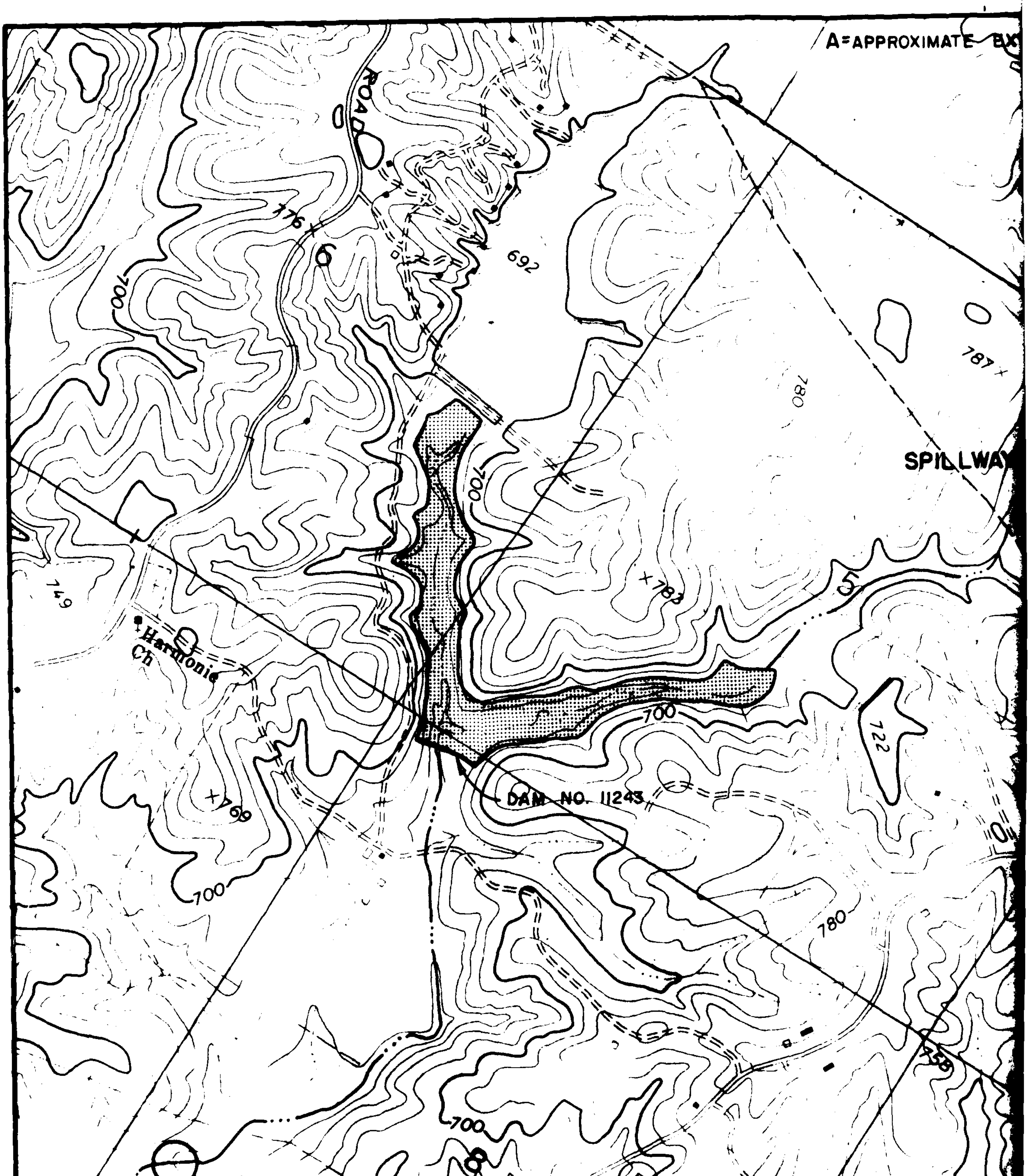




LOCATION MAP

SIEGMUND LAKE DAM
MO 30520

REGIONAL VICINITY MAP



A=APPROXIMATE BX
ROAD
776
692
700
787
780
SPILLWAY
749
Harmonie Ch
783
5
700
722
DAM NO. 11243
769
700
780
700
A

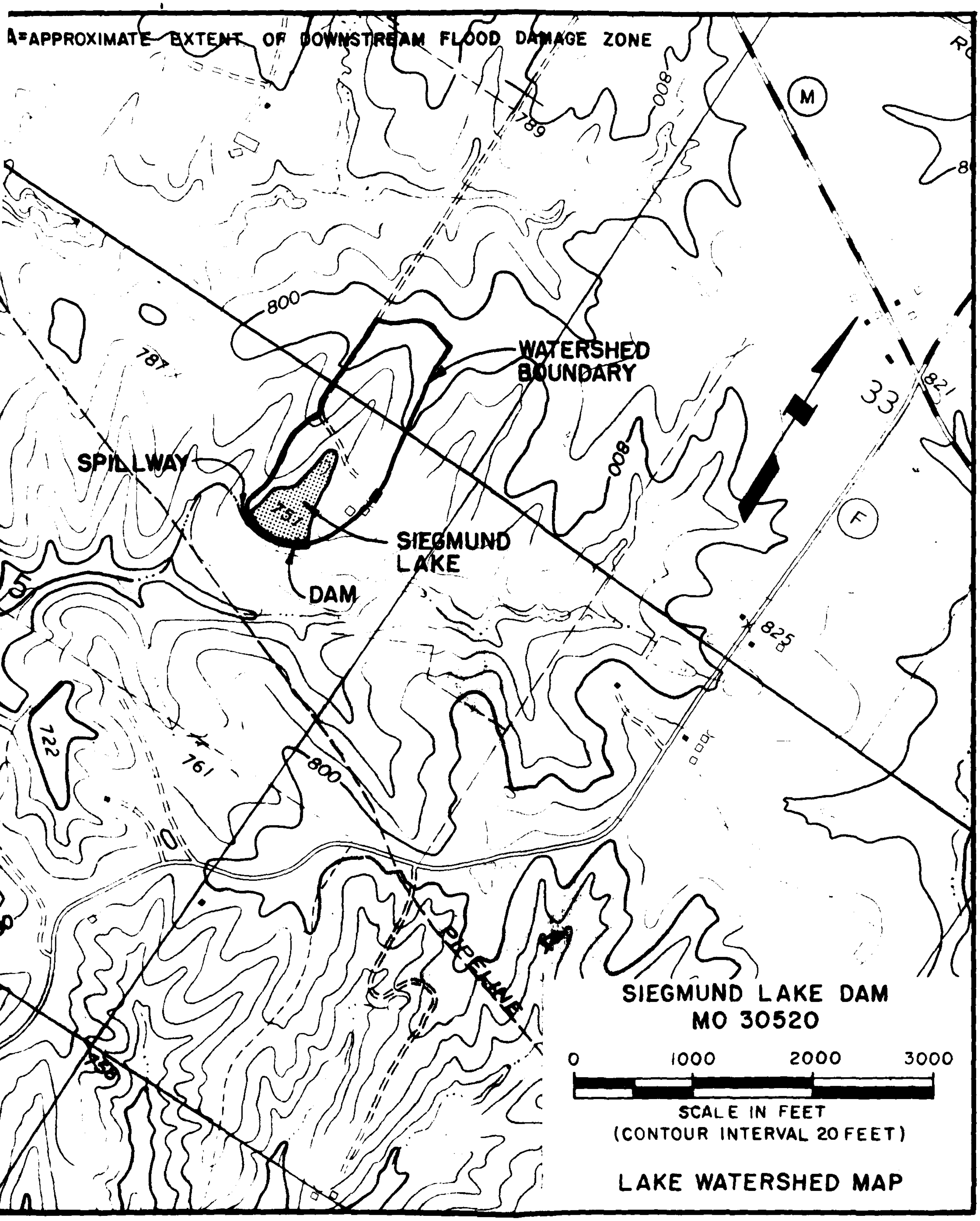
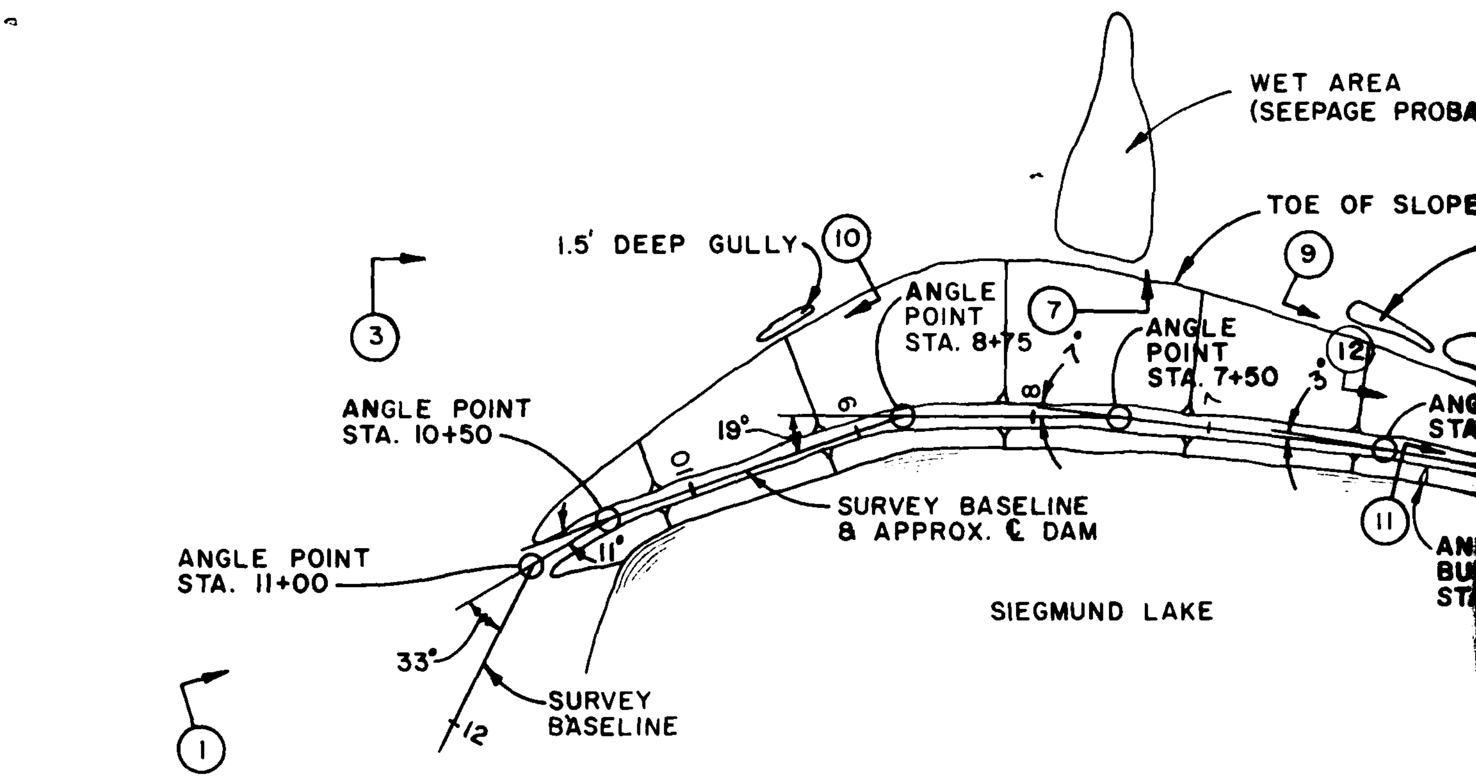
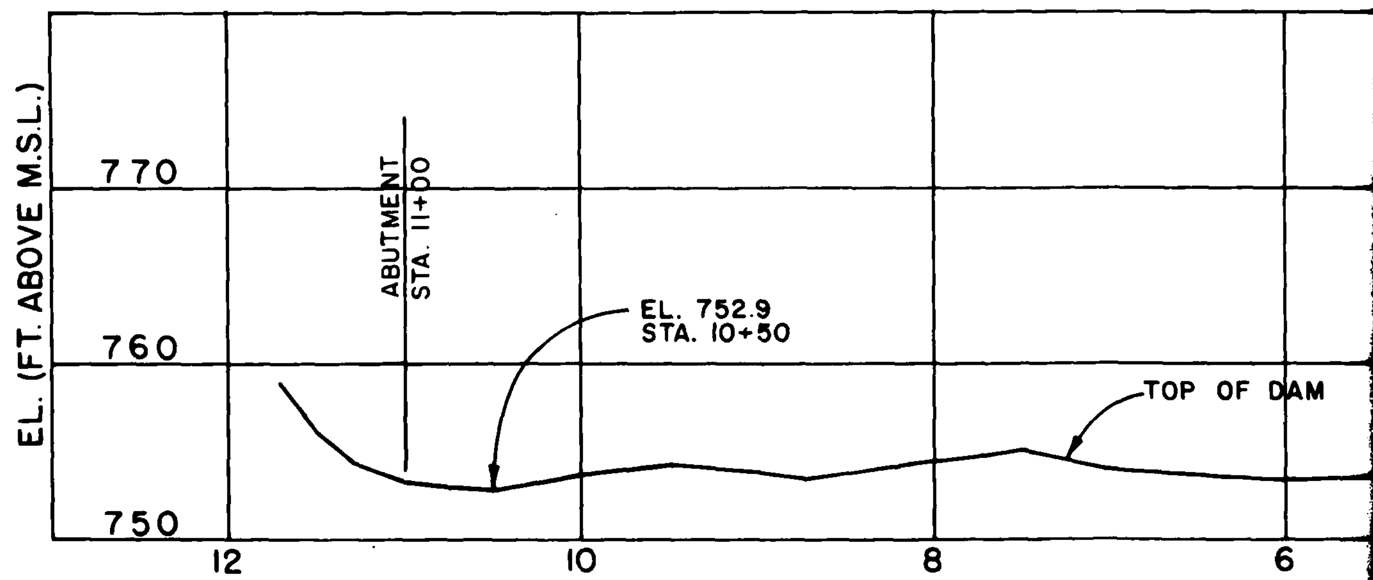

A=APPROXIMATE EXTENT OF DOWNSTREAM FLOOD DAMAGE ZONE
WATERSHED BOUNDARY
SPILLWAY
SIEGMUND LAKE
DAM
PIPELINE
SIEGMUND LAKE DAM
MO 30520
0 1000 2000 3000
SCALE IN FEET
(CONTOUR INTERVAL 20 FEET)
LAKE WATERSHED MAP

PLATE 2



GENERAL PLAN OF DAM

SCALE: 1"=100'

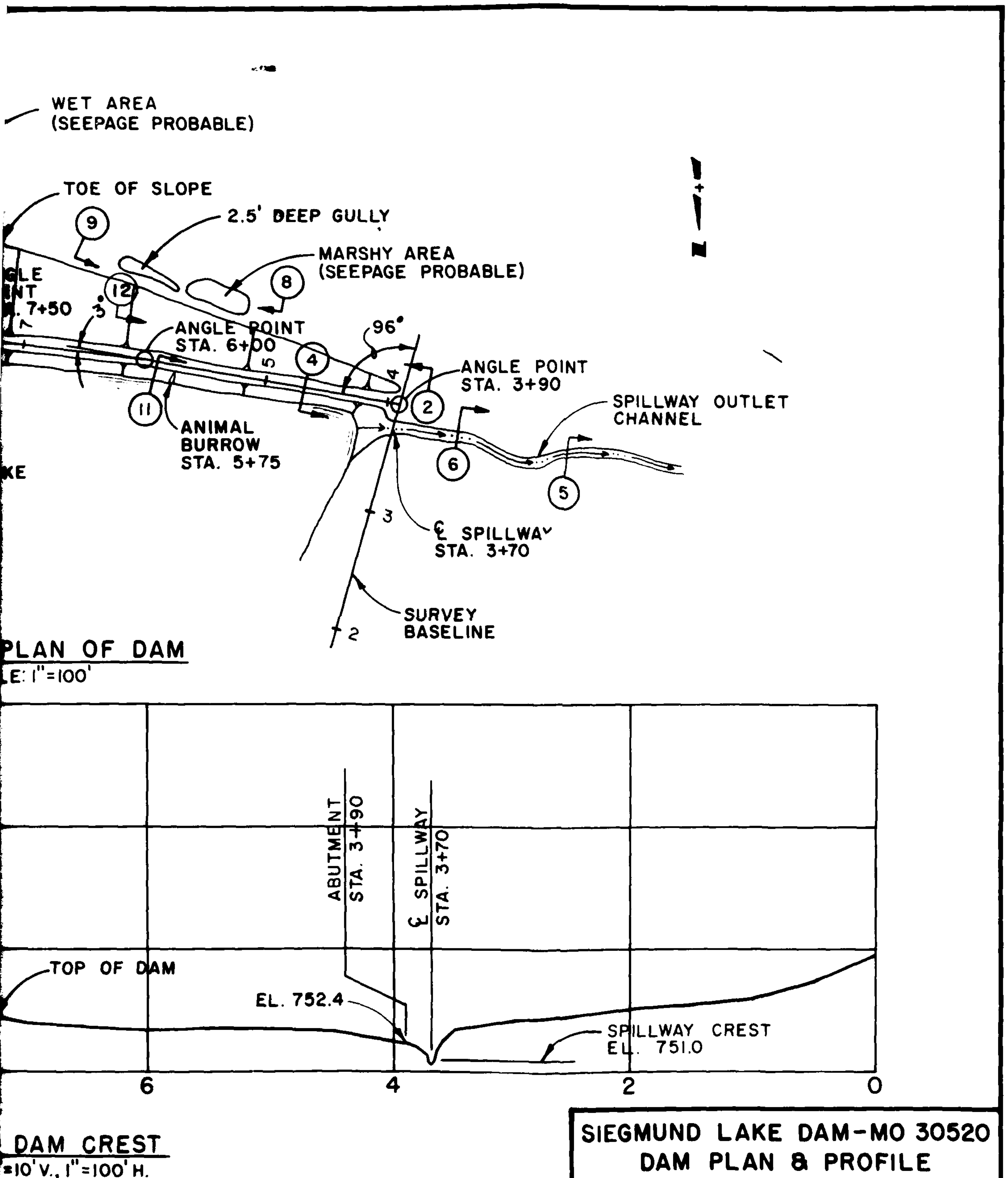


PROFILE DAM CREST

SCALES: 1"=10'V., 1"=100'H.

6

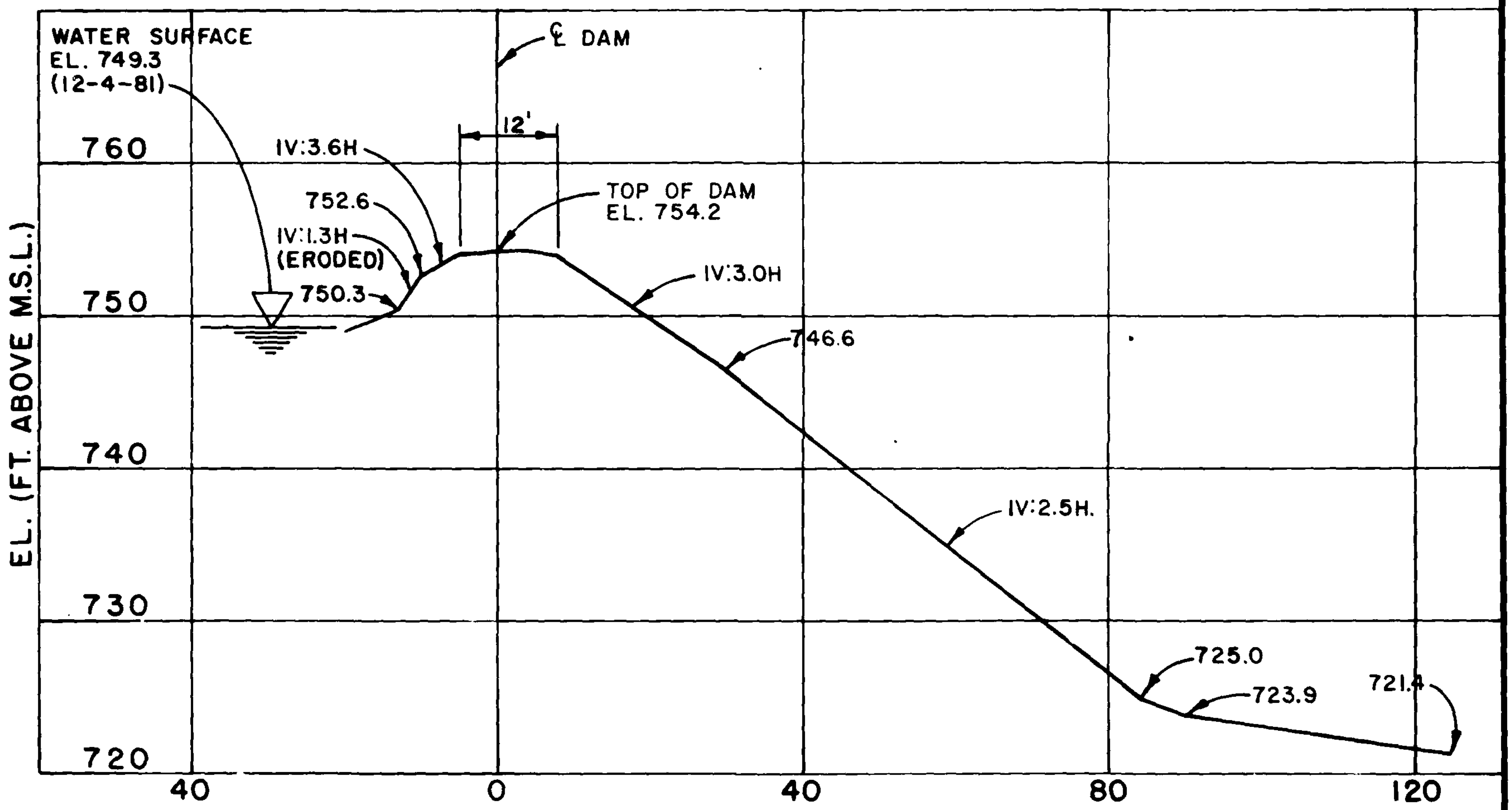
PHOTO LOCATION & KEY
(SEE APPENDIX A)



SIEGMUND LAKE DAM-MO 30520
DAM PLAN & PROFILE

Horner & Shifrin, Inc. March 1981

PLATE 3

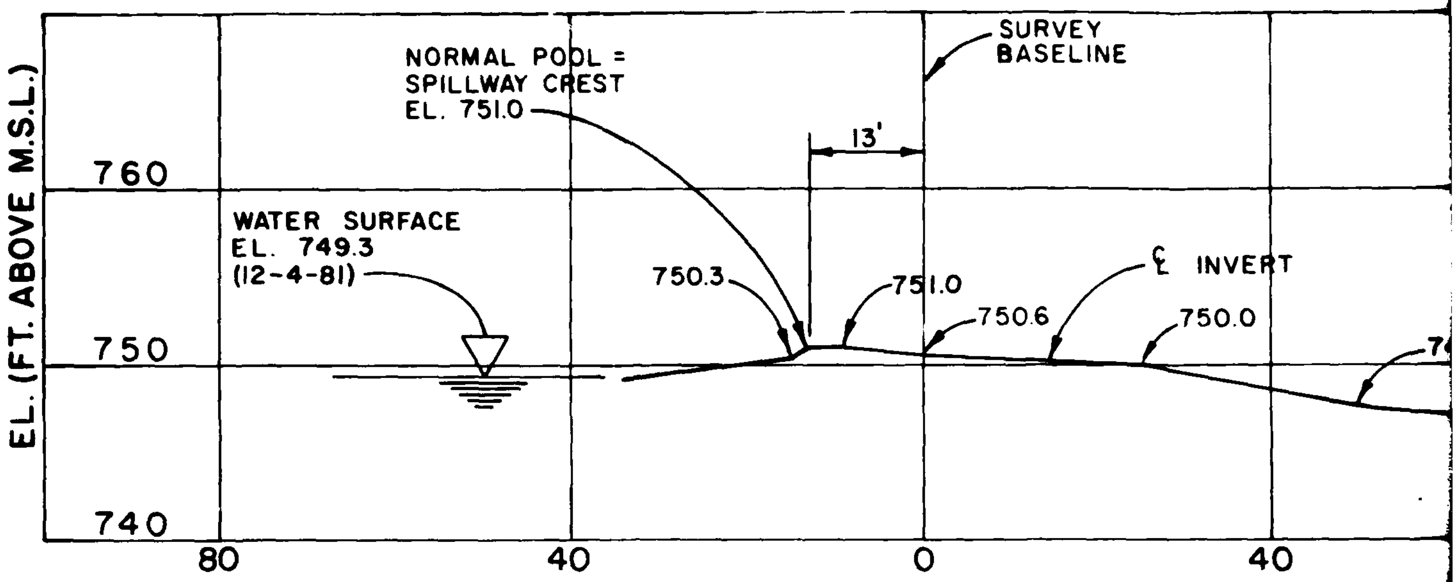


DAM CROSS-SECTION STA. 8+16

SCALES: 1"=10'V., 1"=20'H.

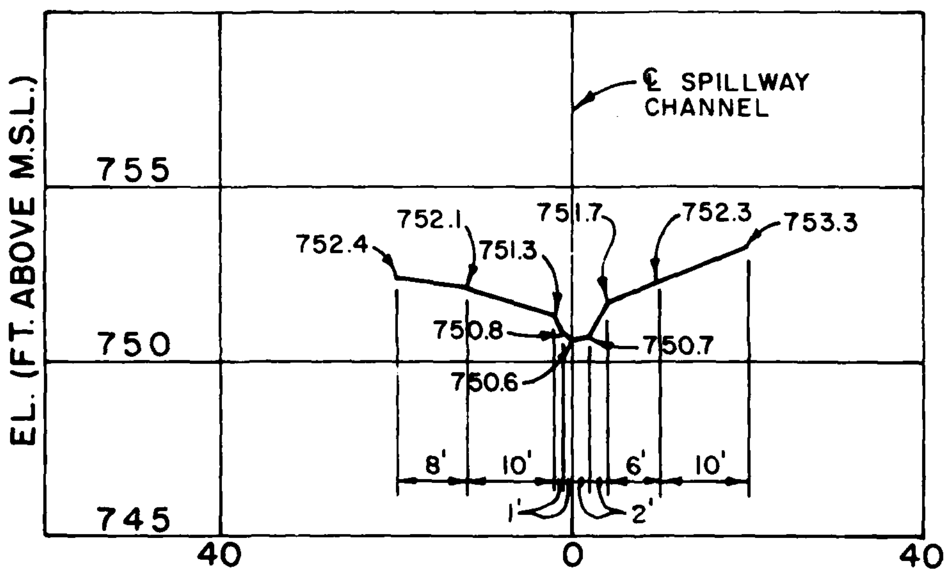
SIEGMUND LAKE DAM–MO 30520
DAM CROSS-SECTION

Horner & Shifrin, Inc. March 1981

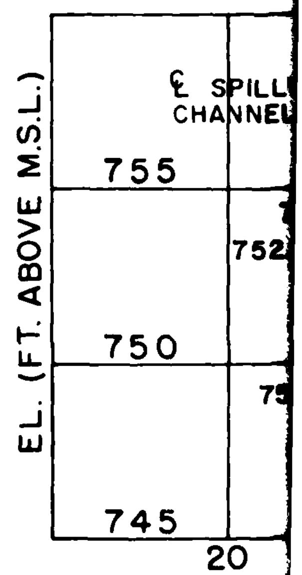


SPILLWAY PROFILE

SCALES: 1"=10'V., 1"=20'H



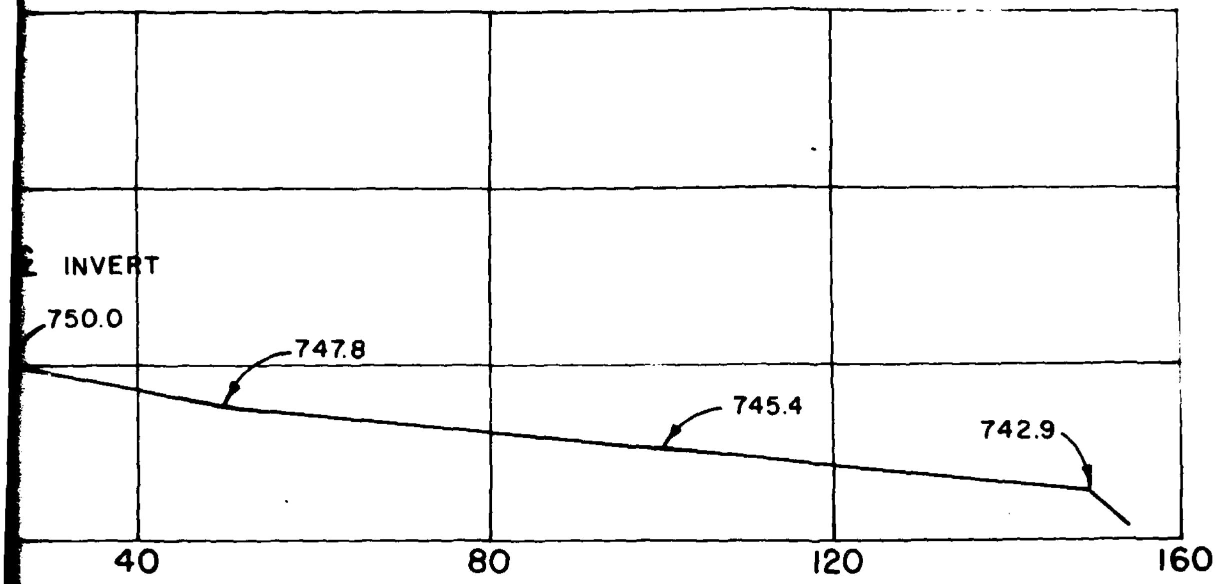
SURVEY BASELINE



25 FT. D

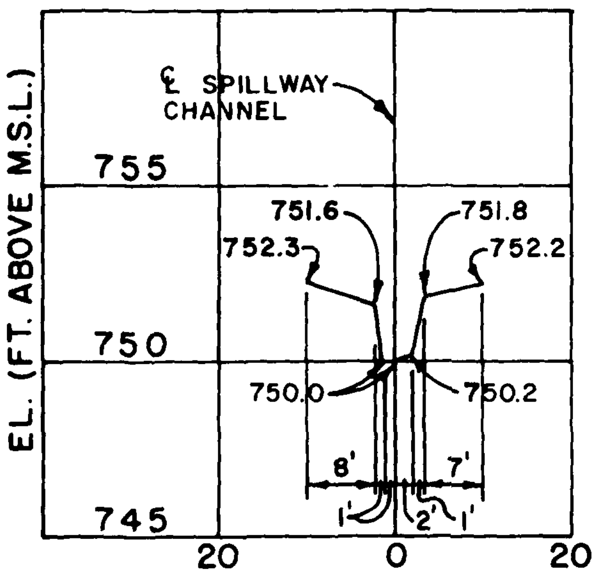
SPILLWAY CROSS-SECT

SCALES: 1"=5'V., 1"=20'H

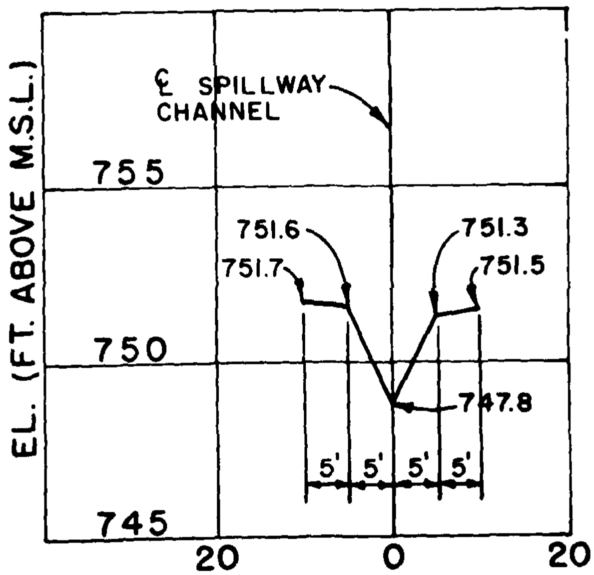


ILLWAY PROFILE

LES: 1"=10'V., 1"=20'H.



25 FT. DOWNSTREAM



50 FT. DOWNSTREAM

AY CROSS-SECTIONS

LES: 1"=5'V., 1"=20'H.

SIEGMUND LAKE DAM-MO 30520
SPILLWAY PROFILE &
CROSS-SECTIONS
Horner & Shifrin, Inc. March 1981

PLATE 5

APPENDIX A

INSPECTION PHOTOGRAPHS

1	2
3	X

PHOTO KEY

NO.	DESCRIPTION
1	Dam Overview
2	Upstream Face of Dam
3	Downstream Face of Dam

4	5
6	

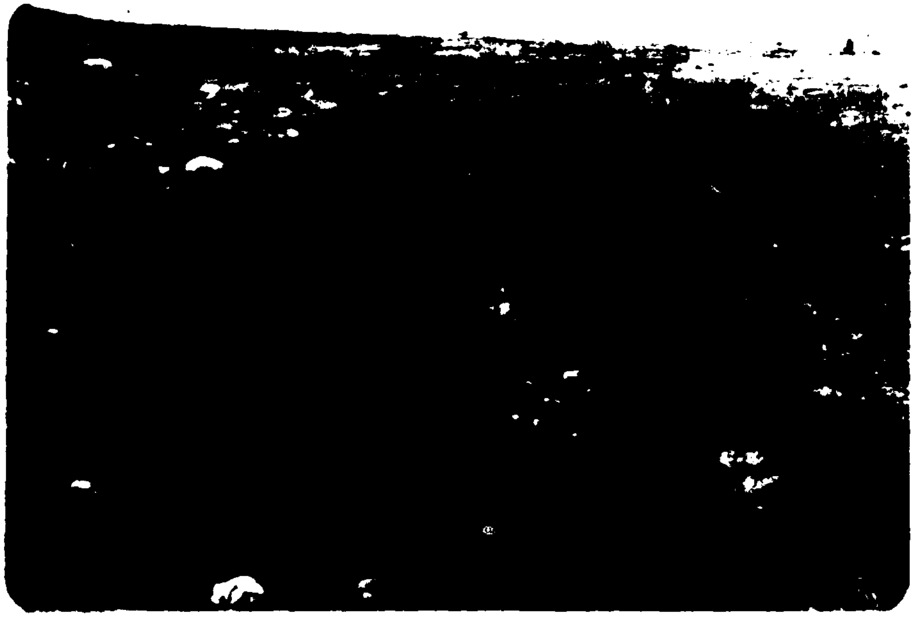
PHOTO KEY

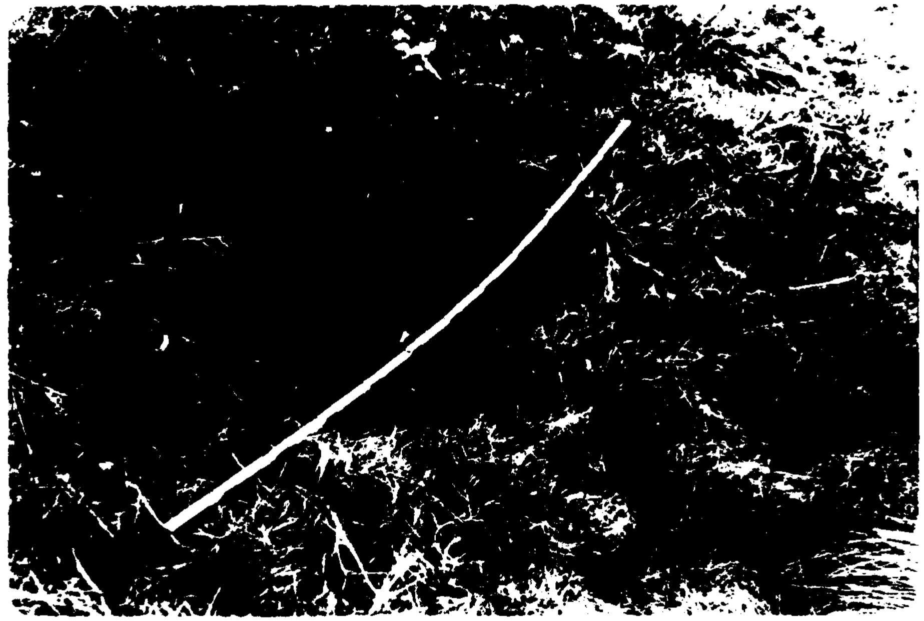
NO.	DESCRIPTION
4	Excavated Earth Spillway
5	Spillway, Outlet Channel
6	Protected Section of Spillway Channel

7	8
9	

PHOTO KEY

NO.	DESCRIPTION
7	Wet Area Opposite Sta. 7+65±
8	Marshy Area Opposite Sta. 5+55±
9	Erosion Gully Opposite Sta. 6+35±





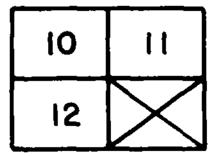


PHOTO KEY

NO.	DESCRIPTION
10	Erosion Gully Opposite Sta. 9+05
11	Dam Subsidence at Animal Burrow
12	Trees in Downstream Face of Dam

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 25.0 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent chance (100-year frequency) flood was provided by the St. Louis District, Corps of Engineers.

b. Storm duration = 24 hours, unit hydrograph duration = 5 minutes.

c. Drainage area = 0.053 square miles = 34 acres.

d. SCS parameters:

Time of Concentration (T_C) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.110 hours

Where: T_C = Travel time of water from hydraulically most distant point to point of interest, hours.

L = Length of longest watercourse = 0.246 miles.

H = Elevation difference = 54 feet.

The time of concentration (T_C) was obtained using method C as described in Fig. 30, "Design of Small Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Lag time = 0.066 hours (0.60 T_C)

Hydrologic Soil Group = 36% C (Hatton Series) + 64% D (Keswick Series) per County SCS Soil Report

Soil type CN = 84 (AMC II, 100-yr flood)
= 93 (AMC III, PMF condition)

2. The spillway consists of a broad-crested trapezoidal section, for which conventional weir formulas are unsuitable for this application. Spillway release rates were determined as follows:

a. Spillway crest section properties (areas, "a", and top width, "t") were computed for various depths, "d".

b. It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth Q_c was computed as $Q_c = (\frac{a^3 g}{t})^{0.5}$ for the various depths, "d". Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.* Reference "Handbook of Hydraulics", Fifth Edition, by King & Brater, page 8-7.

c. Static lake levels corresponding to the various flow values passing the spillway were computed as critical depths plus critical velocity heads ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

d. The spillway discharges for corresponding elevations were entered on the Y4 and Y5 cards.

3. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and $V cards. The program assumes that flow over the dam crest occurs at critical depth and computes internally the flow passing the dam crest and adds this flow to the flow passing the spillways as entered on the Y4 and Y5 cards.

* $v_c = \frac{Qc}{a}$; $Hvc = \frac{v_c^2}{2g}$

```
A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SIEGMUND LAKE DAM
A3      RATIOS OF PMF ROUTED THROUGH RESERVOIR
B     288       0       5                                               0
B1      5
J       1       4       1
J1    .24     .25     .50     1.0
K       0  INFLOW                                       1
K1      INFLOW HYDROGRAPH
M       1       2   0.053                     1.0                       1
P       0    25.0     102     120     130
T                                               -1     -93
W2          0.066
X    -1.0    -.10     2.0
K       1     DAM                                       1
K1      RESERVOIR ROUTING BY MODIFIED PULS
Y                               1       1
Y1      1                                    -751.      -1
Y4    751   751.5     752   752.5  752.82   753.2   753.5  753.85  754.25   754.5
Y4754.75      755
Y5      0       5      25      65     100     155     200     300     425     530
Y5    660     800
$A      0     6.3    11.3    16.8      21

$E    730     751     760     770     780
$$ 751.0
$D 752.4
$L      0      10      30      70     160     280     330     625     745     760
$V 752.4   752.7   752.9     753   753.4   753.6   753.6   754.2   755.1   756.2
K      99
```

```
A1       ANALYSIS OF DAM OVERTOPPING USING 1% CHANCE FLOOD
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SIEGMUND LAKE DAM
A3       1% CHANCE FLOOD ROUTED THROUGH RESERVOIR
B     288       0       5                                               4
BI      5
J       1       1       1
J1     1.
K       0  INFLOW                                       1
K1        INFLOW HYDROGRAPH
M       0       2   0.053                       1.0                     1
O     288   7.094
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1   .006    .006    .014    .014    .014    .014    .014    .014    .014    .014
O1   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
O1   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
O1   .014    .014    .014    .014    .014    .014    .014    .014    .024    .024
O1   .024    .024    .024    .024    .024    .024    .024    .024    .024    .024
O1   .024    .024    .024    .024    .024    .024    .029    .029    .029    .029
O1   .029    .029    .060    .060    .060    .060    .060    .060    .129    .129
O1   .130    .247    .247    .546    .826    .380    .247    .130    .130    .129
O1   .060    .060    .060    .060    .060    .060    .029    .029    .029    .029
O1   .029    .029    .024    .024    .024    .024    .024    .024    .024    .024
O1   .024    .024    .024    .024    .024    .024    .024    .024    .024    .024
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O1  .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
O1  .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
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O1  .014    .014    .014    .014    .014    .014    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
O1  .006    .006    .006    .006    .006    .006    .006    .006
T                                                     -1     -84
W7         0.066
X   -1.0    -.10     2.0
K      1     DAM                                       1
K1       RESERVOIR ROUTING BY MODIFIED PULS
Y                                1       1
Y1     1                                          -751.       -1
Y4   751   751.5     752   752.5  752.82   753.2   753.5  753.85  754.25   754.5
Y4754.75     755
Y5     0       5      25      65     100     155     200     300     425     530
Y5   660     800
$A     0     6.3    11.3    16.8      21
$E   730     751     760     770     780
$$ 751.0
$D 752.4
$L     0      10      30      70     160     280     330     625     745     760
$V 752.4   752.7   752.9     753   753.4   753.6   753.6   754.2   755.1   756.2
K     99
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SIEGMUND LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .20 .25 .50 1.00

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.05	0.00	.05	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.00	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-93.00	0.00	0.00

CURVE NO = -93.00 WETNESS = -1.00 EFFECT CN = 93.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .07

RECESSION DATA
STRTQ= -1.00 QRCSN= -.10 RTIOR= 2.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 6 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .07 VOL= 1.00
210. 145. 40. 11. 3. ..

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.21	.21	.00	56.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.21	.21	.00	78.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.21	.21	.00	84.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.21	.21	.00	85.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.21	.21	.00	86.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.21	.21	.00	86.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.21	.21	.00	86.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.00	86.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.00	86.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.00	86.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.21	.00	86.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.21	.00	86.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.26	.25	.00	95.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.26	.25	.00	102.
1.01	1.15	15	.01	.00	.01	1.	1.01	13.15	159	.26	.25	.00	103.
1.01	1.20	16	.01	.00	.01	1.	1.01	13.20	160	.26	.25	.00	104.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.25	161	.26	.25	.00	104.
1.01	1.30	18	.01	.00	.01	1.	1.01	13.30	162	.26	.25	.00	104.
1.01	1.35	19	.01	.00	.01	1.	1.01	13.35	163	.26	.25	.00	104.
1.01	1.40	20	.01	.00	.01	1.	1.01	13.40	164	.26	.25	.00	104.
1.01	1.45	21	.01	.00	.01	2.	1.01	13.45	165	.26	.25	.00	104.
1.01	1.50	22	.01	.00	.01	2.	1.01	13.50	166	.26	.25	.00	104.
1.01	1.55	23	.01	.00	.01	2.	1.01	13.55	167	.26	.25	.00	104.
1.01	2.00	24	.01	.00	.01	2.	1.01	14.00	168	.26	.25	.00	104.
1.01	2.05	25	.01	.01	.01	2.	1.01	14.05	169	.32	.32	.00	118.
1.01	2.10	26	.01	.01	.01	2.	1.01	14.10	170	.32	.32	.00	127.
1.01	2.15	27	.01	.01	.01	2.	1.01	14.15	171	.32	.32	.00	129.
1.01	2.20	28	.01	.01	.01	2.	1.01	14.20	172	.32	.32	.00	130.
1.01	2.25	29	.01	.01	.01	2.	1.01	14.25	173	.32	.32	.00	130.
1.01	2.30	30	.01	.01	.01	2.	1.01	14.30	174	.32	.32	.00	130.
1.01	2.35	31	.01	.01	.01	3.	1.01	14.35	175	.32	.32	.00	130.
1.01	2.40	32	.01	.01	.01	3.	1.01	14.40	176	.32	.32	.00	130.
1.01	2.45	33	.01	.01	.01	3.	1.01	14.45	177	.32	.32	.00	130.
1.01	2.50	34	.01	.01	.01	3.	1.01	14.50	178	.32	.32	.00	130.
1.01	2.55	35	.01	.01	.01	3.	1.01	14.55	179	.32	.32	.00	130.
1.01	3.00	36	.01	.01	.01	3.	1.01	15.00	180	.32	.32	.00	130.
1.01	3.05	37	.01	.01	.01	3.	1.01	15.05	181	.19	.19	.00	104.
1.01	3.10	38	.01	.01	.01	3.	1.01	15.10	182	.39	.39	.00	127.
1.01	3.15	39	.01	.01	.01	3.	1.01	15.15	183	.39	.39	.00	150.
1.01	3.20	40	.01	.01	.01	3.	1.01	15.20	184	.58	.58	.00	197.
1.01	3.25	41	.01	.01	.01	3.	1.01	15.25	185	.68	.68	.00	247.
1.01	3.30	42	.01	.01	.01	3.	1.01	15.30	186	1.65	1.64	.00	473.
1.01	3.35	43	.01	.01	.01	3.	1.01	15.35	187	2.71	2.71	.00	843.
1.01	3.40	44	.01	.01	.01	3.	1.01	15.40	188	1.07	1.06	.00	692.
1.01	3.45	45	.01	.01	.01	3.	1.01	15.45	189	.68	.68	.00	426.
1.01	3.50	46	.01	.01	.01	4.	1.01	15.50	190	.58	.58	.00	299.
1.01	3.55	47	.01	.01	.01	4.	1.01	15.55	191	.39	.39	.00	214.
1.01	4.00	48	.01	.01	.00	4.	1.01	16.00	192	.39	.39	.00	174.
1.01	4.05	49	.01	.01	.00	4.	1.01	16.05	193	.30	.30	.00	144.
1.01	4.10	50	.01	.01	.00	4.	1.01	16.10	194	.30	.30	.00	128.
1.01	4.15	51	.01	.01	.00	4.	1.01	16.15	195	.30	.30	.00	123.
1.01	4.20	52	.01	.01	.00	4.	1.01	16.20	196	.30	.30	.00	122.
1.01	4.25	53	.01	.01	.00	4.	1.01	16.25	197	.30	.30	.00	122.

1.01	4.30	54	.01	.01	.00	4.	1.01	16.30	198	.30	.30	.00	122.
1.01	4.35	55	.01	.01	.00	4.	1.01	16.35	199	.30	.30	.00	122.
1.01	4.40	56	.01	.01	.00	4.	1.01	16.40	200	.30	.30	.00	122.
1.01	4.45	57	.01	.01	.00	4.	1.01	16.45	201	.30	.30	.00	122.
1.01	4.50	58	.01	.01	.00	4.	1.01	16.50	202	.30	.30	.00	122.
1.01	4.55	59	.01	.01	.00	4.	1.01	16.55	203	.30	.30	.00	122.
1.01	5.00	60	.01	.01	.00	4.	1.01	17.00	204	.30	.30	.00	122.
1.01	5.05	61	.01	.01	.00	4.	1.01	17.05	205	.23	.23	.00	109.
1.01	5.10	62	.01	.01	.00	4.	1.01	17.10	206	.23	.23	.00	99.
1.01	5.15	63	.01	.01	.00	4.	1.01	17.15	207	.23	.23	.00	97.
1.01	5.20	64	.01	.01	.00	4.	1.01	17.20	208	.23	.23	.00	96.
1.01	5.25	65	.01	.01	.00	4.	1.01	17.25	209	.23	.23	.00	96.
1.01	5.30	66	.01	.01	.00	4.	1.01	17.30	210	.23	.23	.00	96.
1.01	5.35	67	.01	.01	.00	4.	1.01	17.35	211	.23	.23	.00	96.
1.01	5.40	68	.01	.01	.00	4.	1.01	17.40	212	.23	.23	.00	96.
1.01	5.45	69	.01	.01	.00	4.	1.01	17.45	213	.23	.23	.00	96.
1.01	5.50	70	.01	.01	.00	4.	1.01	17.50	214	.23	.23	.00	96.
1.01	5.55	71	.01	.01	.00	4.	1.01	17.55	215	.23	.23	.00	96.
1.01	6.00	72	.01	.01	.00	4.	1.01	18.00	216	.23	.23	.00	96.
1.01	6.05	73	.06	.05	.01	13.	1.01	18.05	217	.02	.02	.00	80.
1.01	6.10	74	.06	.05	.01	18.	1.01	18.10	218	.02	.02	.00	75.
1.01	6.15	75	.06	.05	.01	20.	1.01	18.15	219	.02	.02	.00	70.
1.01	6.20	76	.06	.05	.01	21.	1.01	18.20	220	.02	.02	.00	65.
1.01	6.25	77	.06	.05	.01	21.	1.01	18.25	221	.02	.02	.00	61.
1.01	6.30	78	.06	.05	.01	22.	1.01	18.30	222	.02	.02	.00	57.
1.01	6.35	79	.06	.05	.01	22.	1.01	18.35	223	.02	.02	.00	53.
1.01	6.40	80	.06	.05	.01	22.	1.01	18.40	224	.02	.02	.00	49.
1.01	6.45	81	.06	.05	.01	22.	1.01	18.45	225	.02	.02	.00	46.
1.01	6.50	82	.06	.06	.01	23.	1.01	18.50	226	.02	.02	.00	43.
1.01	6.55	83	.06	.06	.01	23.	1.01	18.55	227	.02	.02	.00	40.
1.01	7.00	84	.06	.06	.01	23.	1.01	19.00	228	.02	.02	.00	37.
1.01	7.05	85	.06	.06	.01	23.	1.01	19.05	229	.02	.02	.00	35.
1.01	7.10	86	.06	.06	.01	23.	1.01	19.10	230	.02	.02	.00	33.
1.01	7.15	87	.06	.06	.01	23.	1.01	19.15	231	.02	.02	.00	30.
1.01	7.20	88	.06	.06	.01	23.	1.01	19.20	232	.02	.02	.00	28.
1.01	7.25	89	.06	.06	.01	23.	1.01	19.25	233	.02	.02	.00	26.
1.01	7.30	90	.06	.06	.00	24.	1.01	19.30	234	.02	.02	.00	25.
1.01	7.35	91	.06	.06	.00	24.	1.01	19.35	235	.02	.02	.00	23.
1.01	7.40	92	.06	.06	.00	24.	1.01	19.40	236	.02	.02	.00	21.
1.01	7.45	93	.06	.06	.00	24.	1.01	19.45	237	.02	.02	.00	20.
1.01	7.50	94	.06	.06	.00	24.	1.01	19.50	238	.02	.02	.00	19.
1.01	7.55	95	.06	.06	.00	24.	1.01	19.55	239	.02	.02	.00	17.
1.01	8.00	96	.06	.06	.00	24.	1.01	20.00	240	.02	.02	.00	16.
1.01	8.05	97	.06	.06	.00	24.	1.01	20.05	241	.02	.02	.00	15.
1.01	8.10	98	.06	.06	.00	24.	1.01	20.10	242	.02	.02	.00	14.
1.01	8.15	99	.06	.06	.00	24.	1.01	20.15	243	.02	.02	.00	13.
1.01	8.20	100	.06	.06	.00	24.	1.01	20.20	244	.02	.02	.00	12.
1.01	8.25	101	.06	.06	.00	24.	1.01	20.25	245	.02	.02	.00	12.
1.01	8.30	102	.06	.06	.00	24.	1.01	20.30	246	.02	.02	.00	11.
1.01	8.35	103	.06	.06	.00	24.	1.01	20.35	247	.02	.02	.00	10.
1.01	8.40	104	.06	.06	.00	24.	1.01	20.40	248	.02	.02	.00	9.
1.01	8.45	105	.06	.06	.00	25.	1.01	20.45	249	.02	.02	.00	9.
1.01	8.50	106	.06	.06	.00	25.	1.01	20.50	250	.02	.02	.00	9.
1.01	8.55	107	.06	.06	.00	25.	1.01	20.55	251	.02	.02	.00	9.
1.01	9.00	108	.06	.06	.00	25.	1.01	21.00	252	.02	.02	.00	9.
1.01	9.05	109	.06	.06	.00	25.	1.01	21.05	253	.02	.02	.00	9.
1.01	9.10	110	.06	.06	.00	25.	1.01	21.10	254	.02	.02	.00	9.

END-OF-PERIOD FLOW (Cont'd)

1.01	9.15	111	.06	.06	.00	25.	1.01	21.15	255	.02	.02	.00	9.
1.01	9.20	112	.06	.06	.00	25.	1.01	21.20	256	.02	.02	.00	9.
1.01	9.25	113	.06	.06	.00	25.	1.01	21.25	257	.02	.02	.00	9.
1.01	9.30	114	.06	.06	.00	25.	1.01	21.30	258	.02	.02	.00	9.
1.01	9.35	115	.06	.06	.00	25.	1.01	21.35	259	.02	.02	.00	9.
1.01	9.40	116	.06	.06	.00	25.	1.01	21.40	260	.02	.02	.00	9.
1.01	9.45	117	.06	.06	.00	25.	1.01	21.45	261	.02	.02	.00	9.
1.01	9.50	118	.06	.06	.00	25.	1.01	21.50	262	.02	.02	.00	9.
1.01	9.55	119	.06	.06	.00	25.	1.01	21.55	263	.02	.02	.00	9.
1.01	10.00	120	.06	.06	.00	25.	1.01	22.00	264	.02	.02	.00	9.
1.01	10.05	121	.06	.06	.00	25.	1.01	22.05	265	.02	.02	.00	9.
1.01	10.10	122	.06	.06	.00	25.	1.01	22.10	266	.02	.02	.00	9.
1.01	10.15	123	.06	.06	.00	25.	1.01	22.15	267	.02	.02	.00	9.
1.01	10.20	124	.06	.06	.00	25.	1.01	22.20	268	.02	.02	.00	9.
1.01	10.25	125	.06	.06	.00	25.	1.01	22.25	269	.02	.02	.00	9.
1.01	10.30	126	.06	.06	.00	25.	1.01	22.30	270	.02	.02	.00	9.
1.01	10.35	127	.06	.06	.00	25.	1.01	22.35	271	.02	.02	.00	9.
1.01	10.40	128	.06	.06	.00	25.	1.01	22.40	272	.02	.02	.00	9.
1.01	10.45	129	.06	.06	.00	25.	1.01	22.45	273	.02	.02	.00	9.
1.01	10.50	130	.06	.06	.00	25.	1.01	22.50	274	.02	.02	.00	9.
1.01	10.55	131	.06	.06	.00	25.	1.01	22.55	275	.02	.02	.00	9.
1.01	11.00	132	.06	.06	.00	25.	1.01	23.00	276	.02	.02	.00	9.
1.01	11.05	133	.06	.06	.00	25.	1.01	23.05	277	.02	.02	.00	9.
1.01	11.10	134	.06	.06	.00	25.	1.01	23.10	278	.02	.02	.00	9.
1.01	11.15	135	.06	.06	.00	25.	1.01	23.15	279	.02	.02	.00	9.
1.01	11.20	136	.06	.06	.00	25.	1.01	23.20	280	.02	.02	.00	9.
1.01	11.25	137	.06	.06	.00	25.	1.01	23.25	281	.02	.02	.00	9.
1.01	11.30	138	.06	.06	.00	25.	1.01	23.30	282	.02	.02	.00	9.
1.01	11.35	139	.06	.06	.00	25.	1.01	23.35	283	.02	.02	.00	9.
1.01	11.40	140	.06	.06	.00	25.	1.01	23.40	284	.02	.02	.00	9.
1.01	11.45	141	.06	.06	.00	25.	1.01	23.45	285	.02	.02	.00	9.
1.01	11.50	142	.06	.06	.00	25.	1.01	23.50	286	.02	.02	.00	9.
1.01	11.55	143	.06	.06	.00	25.	1.01	23.55	287	.02	.02	.00	9.
1.01	12.00	144	.06	.06	.00	25.	1.02	0.00	288	.02	.02	.00	9.

SUM	32.50	31.61	.89	13708.
	(825.)(	803.)(	23.)(	388.17)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	843.	145.	48.	48.	13694.
CMS	24.	4.	1.	1.	388.
INCHES		25.36	33.38	33.38	33.38
MM		644.25	847.90	847.90	847.90
AC-FT		72.	94.	94.	94.
THOUS CU M		88.	116.	116.	116.

SURFACE ARE@-	0.	6.	11.	17.	21.
CAPACITY=	0.	44.	122.	262.	450.
ELEVATION=	730.	751.	760.	770.	780.

SUMMARY OF DAM SAFETY ANALYSIS

PMF

....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	751.00	751.00	752.40
	STORAGE	44.	44.	53.
	OUTFLOW	0.	0.	57.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.24	752.40	.00	53.	57.	.17	15.92	0.00
.25	752.44	.04	54.	61.	.42	15.92	0.00
.50	753.15	.75	59.	188.	2.83	15.75	0.00
1.00	753.76	1.36	63.	645.	6.33	15.67	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1% CHANCE FLOOD

....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	751.00	751.00	752.40
	STORAGE	44.	44.	53.
	OUTFLOW	0.	0.	57.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	752.13	0.00	52.	40.	0.00	12.58	0.00

DATE
ILME